



Language, Space, Time: Anthropological Tools and Scientific Exploration on Mars

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Mars Exploration Rover Mission (MER)



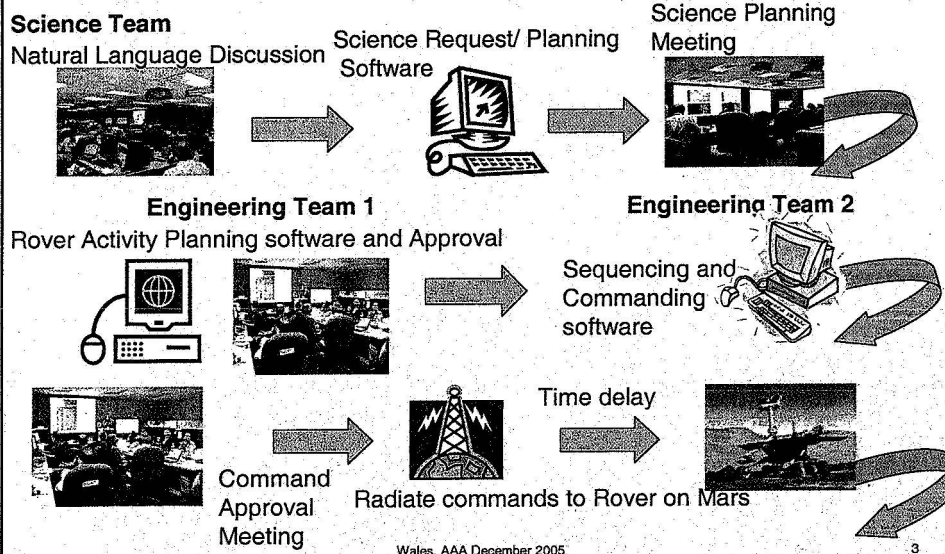
- ▶ Objective: Search for evidence of past water on Mars
- ▶ Landed: January 2004 (launched July 2003)
- ▶ Run for NASA by Jet Propulsion Lab (JPL) in Pasadena, CA. Ames contributed various teams to mission-including work practice evaluation.
- ▶ Mission run on Mars time (Martian sol = 24:39 in Earth time) for four months
 - Solar powered rovers- sunlight and daytime temperatures for cameras and other instruments
- ▶ Work
 - Planning for rover work across science and engineering teams with commands sent to the rover on every sol for execution on the next sol

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Work on Earth that Results in Work on Mars



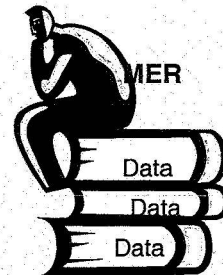
What is Needed to Support this Work?

- ▶ Anthropological Tools for the Scientific Exploration of Mars?
- ▶ Yes. Brought ethnographic methods, "mission ethnography," grounded theory, and anthropological perspectives into the design of a Mars mission
- ▶ Incorporated existing understandings about the salience of Language, Space and Time for understanding cultures and settings
- ▶ Developed:
 - A **Language** to communicate the specifics of the work across the multiple teams and to the rover
 - A **Space** in which to work
 - A way to negotiate the differences between Mars **time** and Earth **time**



Ethnographic Methods for MER

- ▶ Data collection and analysis of:
 - field notes from in-situ observation and participation
 - video and photos
 - documents and artifacts
 - information created in software
 - system interactions between tools
 - information exchanged in meetings
 - nature of individual and group work
 - Interviews (formal and informal)
 - Email information and exchanges
- ▶ Research time- full time for three and a half years (2001 to 2004)



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Devising a Language for Work on Mars

- ▶ Scientists underestimated the complexity of language that was needed to convey their work
 - Early mission scientists' concept of a name to identify work:
 - Target = "Harley"
- ▶ Ethnography identified the need for an expert "language" for Martian work; grounded theory supported the development of that language
 - Mission names incorporating identifiers and relationships of objects.
 - Observation Level = **IDD_Post Scratch_Plymouth Rock**
 - ▶ Take several different kinds of in-situ (IDD) measurements of Plymouth Rock, after scratching the rock with the RAT
 - Activity Level = **Red single Pilgrim**
 - ▶ Take a single frame image of the target spot pilgrim on Plymouth rock, using the red filter of the Pancam

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Examples of Instrument Names, Methods and Other Identifiers/Constraints for use in the Formalization of a Science and Engineering Language for Mars Work

Instrument

APXS
 •Haz
 •MB
 •MI
 •MiniTES
 •Nav
 •Pancam
 •RAT
 •Rover
 •IDD (shorthand for two or more in-situ instruments in one obs)
 •PMA (shorthand for two or more remote sensing instruments in one obs)

Note: PMA and IDD activities belong in separate observations.

Method

- Accordion
- Approach
- Blind (for MiniTES activity without a supporting image or Pancam activity without a target)
- Comparison
- Drive
- Drive camera use methods "quick look", "rubber neck", "systematic"
- Movie
- Rat
- Scratch
- Sniff
- Surveys: Survey around, between, covering, from . . . to, including
- Sweep
- Tau
- Trench

and/or

Other Identifiers/Constraints

- Afternoon
- Around
- Between
- Contiguous (identify whether Mast Relative or Time relative in notes field)
- Elevation
- Location/reference to a region or area
- Long
- Morning
- Morning after
- N, S, E, W (directions)
- Pre
- Post
- Short
- Soil

MER Mission
 1-03-04

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Mission Examples of a Language for Work on Mars

	Mid Mission – two months into mission	End of Nominal Mission- four months into mission
Temporal Constraints	13:30 LST Midday Anytime Post MB Prebrush Sol 46 PreMGS Ultimate/penultimate/antepenultimate	Before 14:30 Post backup Plan A, IF Dist GT .085m Overnight science Pre or Post ODY
Methods	Traverse clast survey Mini-MiniTES Stutter step	Super clast survey Ground Stare 3x1x255 Stares
Purposes	Recon Transient Temperature Doc	Dust Devil Finder Phobos Set
Features	Trex cheek Ejecta blanket IDD work volume	Crater floor Heatshield

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A Space for Work "on" Mars

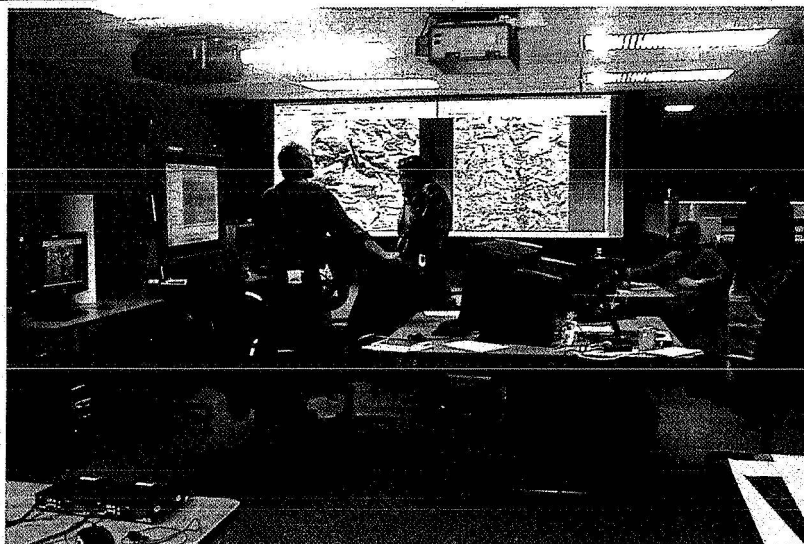
- ▶ How do scientists and engineers do work "on" a planet that is 350 million miles away?
- ▶ Design team members knew what they wanted as functionality (computers, tables, chairs, LAN access), ethnography identified requirements based on the work that was being done.
- ▶ Following work needs identified:
 - The configuration of the space of collaboration
 - A meeting space to suit everyone's needs
 - The conjoining of a "window on Mars" with an electronic virtual world

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Devising a Space – Collaboration on Earth and in a virtual Mars World

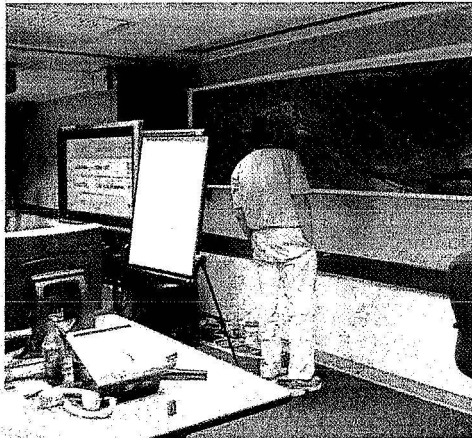


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Devising a Space – Hard copy of a Mars virtual world



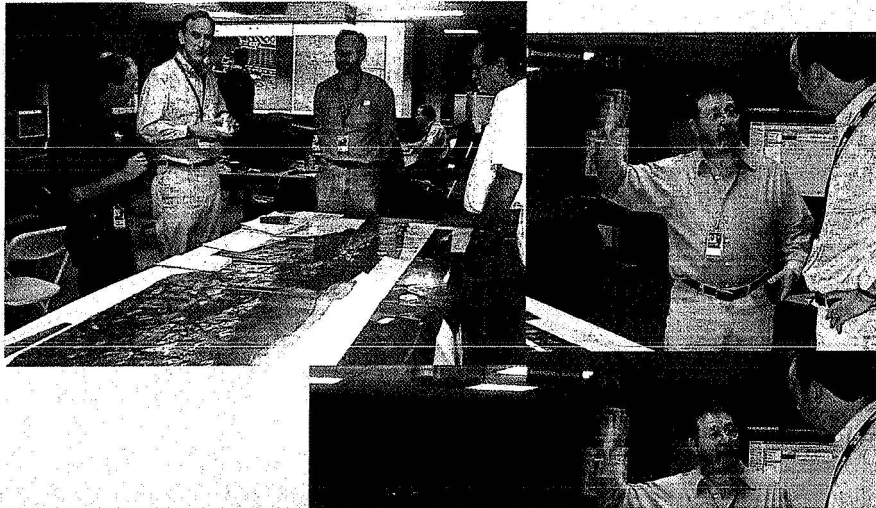
"A window on Mars"

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Image Tables: Multiple "Windows" on Mars

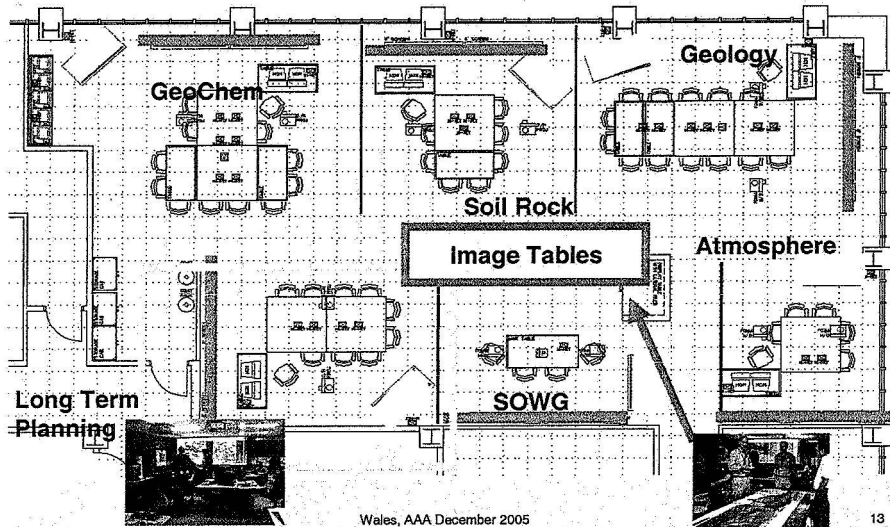


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Facilities: A Space for Scientific Work

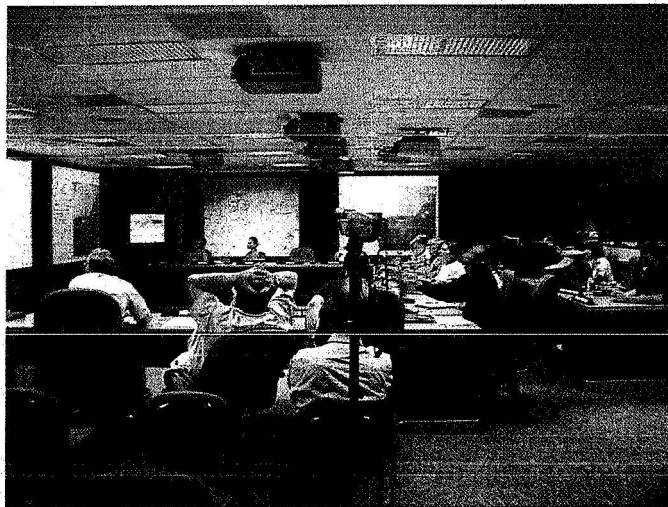


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A Space for Science and Engineering To Meet and Share Artifacts



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Keeping Track of "Time"

- ▶ Engineers' and Mission Manager's pre-mission concept of how time tracking between Mars time and Earth time
 - A standard Earth time clock on the wall and "schedules"
- ▶ As the mission design developed, other relevant "times" were identified: Mission time, 24 hr time, Elapsed mission time; Universal Time Coordinated (UTC), Earth time zones
- ▶ Anthropological understandings of the importance and relative-ness of time within a variety of contexts identified and predicted "time" confusion and the need for a variety of clocks as well as schedules
 - People need to move back and forth across "times":
 - Between Mars work and the world of families and other Earth time responsibilities
 - Work going on in other time zones with university partners
 - Two missions on Mars, one on each side of the planet, time zones are twelve hours and twenty sols apart

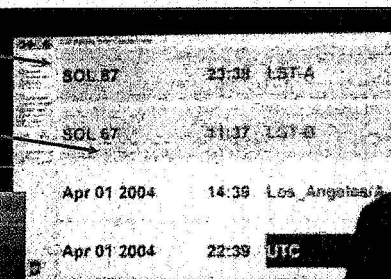
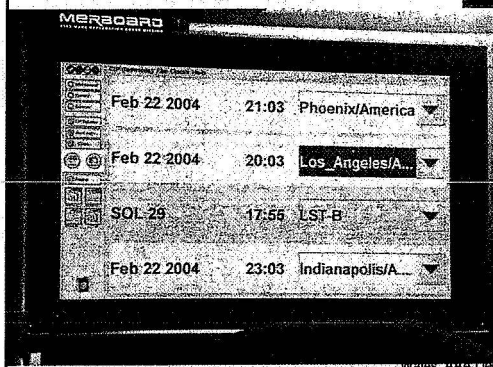
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Keeping Track of "Time"

Spirit Mission A

Opportunity Mission B



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Conclusions

- ▶ "Mission Ethnography", Anthropology, Science and Engineering each brought a different and necessary perspective to the design of the MER Mars Mission.
- ▶ **Space** of interaction was spread across two planets and the work and information in those spaces had to be understood
- ▶ **Time** as an organizer was relative, sequential, circular, delayed, and simultaneous
- ▶ **Language** developed sophistication over period of mission, but first it had to be extracted from the work of the domain
- ▶ Over time, mission participants came to respect what social science had to offer
- ▶ Open question: Is this the first "field work" on another planet?